

A Lighting Ordinance for Ann Arbor

A2 Lighting Ordinance Joint Working Group

March 13/14, 2019

A satellite view of Earth at night, showing the curvature of the planet and the glowing lights of major cities. The lights are concentrated in the eastern United States and southern Canada. The text labels are overlaid on the image.

Chicago

Indianapolis

Detroit

Toronto

A2 Lighting Ordinance Joint Working Group

Sally Oey, University of Michigan
Michigan Dark Skies, local advocacy group

John Mirsky, A2 Energy Commission
Executive Sustainability Advisor, Office of the A2 City Administrator

Erica Briggs, A2 Planning Commission
Executive Director, Scenic Michigan

Sarah Mills, A2 Planning Commission

John Barentine, International Dark Sky Association (IDA)

Mary Stewart Adams, Michigan dark sky advocate
Founder of Headlands International Dark Sky Park

A2LO sponsored by A2 Energy Commission
Josh MacDonald, Sustainability Analyst

Michigan Dark Skies

UM Astronomy

University Lowbrow Astronomers

UM Student Astronomical Society

EMU Physics & Astronomy

Sierra Club Huron Valley Group

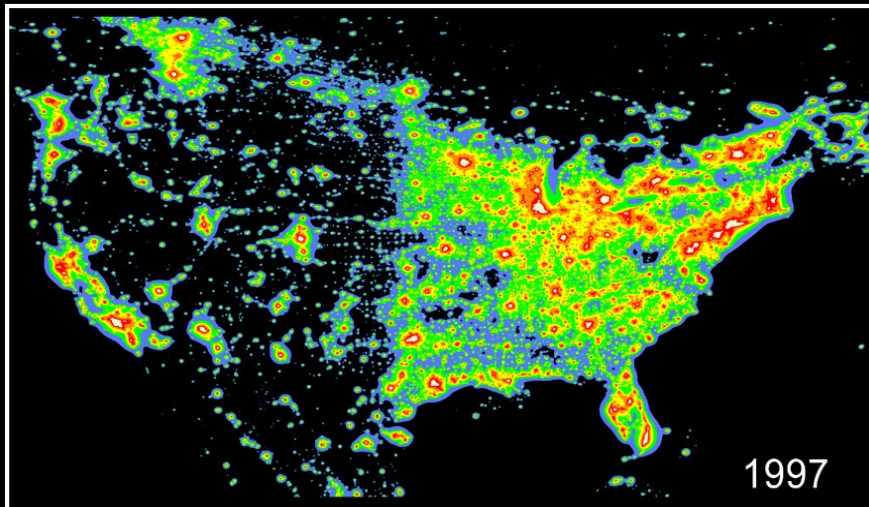
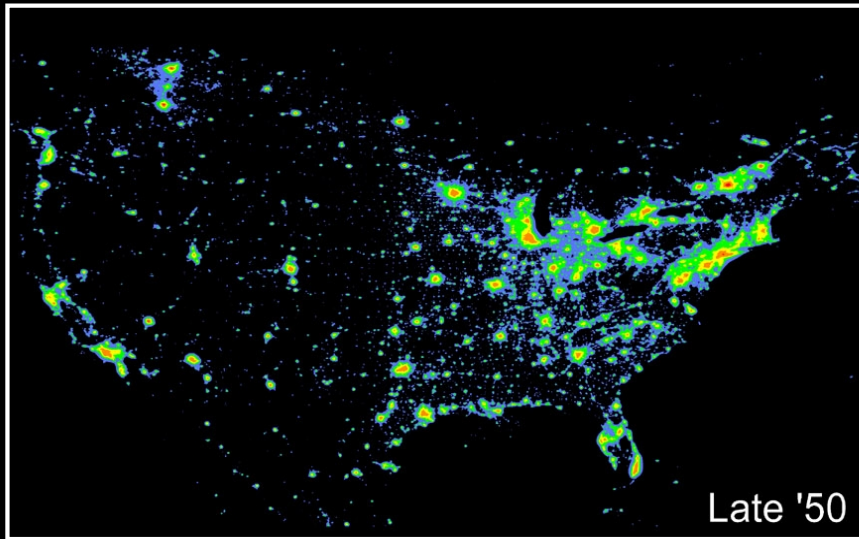
Washtenaw Safe Passage

Detroit Audubon Safe Passage

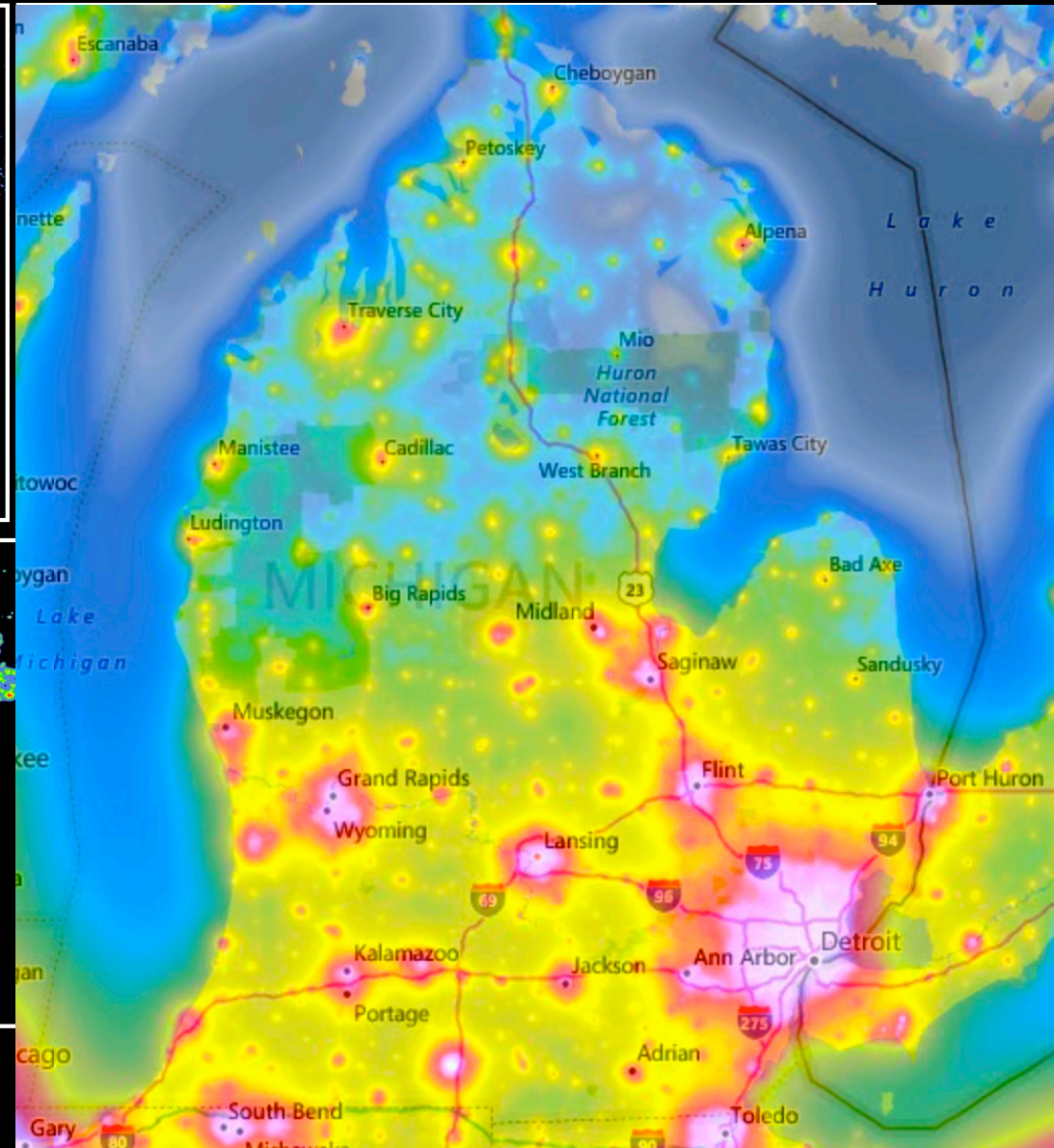
sites.lsa.umich.edu/darkskies

Light Pollution increasing at 6% / yr

(Hoelker et al. 2010)

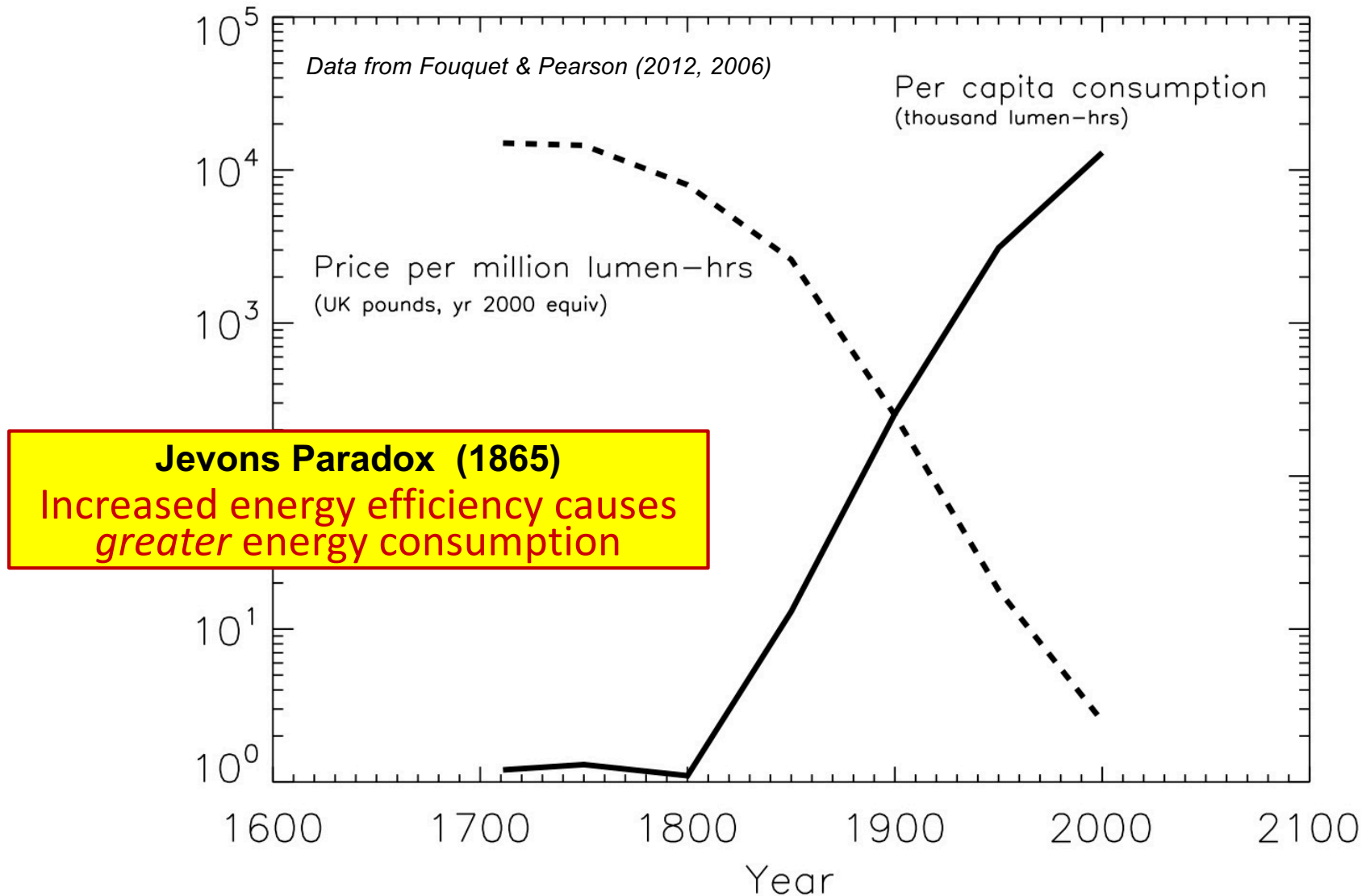


Cinzano, Falchi, and Elvidge (2001)



Will LEDs save energy?

Legislation imperative to realize conservation!



Impacts Biology and Human Health

- 24-hr circadian rhythm, and melatonin production, is disrupted by **artificial light at night (ALAN)**.



The Nobel Prize in Physiology or Medicine 2017
Jeffrey C. Hall, Michael Rosbash, Michael W. Young

“for their discoveries of molecular mechanisms controlling the circadian rhythm”

- ALAN disrupts the ecosystem: birds, nocturnal pollinators, etc.



Yspi: 1 building, 1 night



- Building collisions are #1 cause of bird death
- Birds migrate at night
- Up to a billion birds killed annually

- ✓ Washtenaw Safe Passage
- ✓ Safe Passage Great Lakes, Detroit Audubon Society
- ✓ Fatal Light Awareness Program (FLAP), Toronto
- ✓ Chicago Lights Out Program



- Nocturnal pollinators
- Insects
- Bats
- Sea Turtles
- Fish, incl salmon
- ... and many more

American Medical Association

Report of the Council on Science and Public Health (2016)

*... some evidence supports a long-term increase in the risk for **cancer, diabetes, cardiovascular disease and obesity** from chronic sleep disruption or shiftwork and associated with exposure to brighter light sources in the evening or night.*

*... excessive blue wavelength. This feature further contributes to **disability glare**, i.e., visual impairment due to stray light, as blue wavelengths are associated with more scattering in the human eye, and sufficiently intense **blue spectrum damages retinas**.*

It is well known that unshielded light sources cause pupillary constriction... This leads to worse vision than if the light never existed at all, defeating the purpose of the lighting fixture.

3 Types of Light Pollution:



West Seattle
Bike Connections

Glare

Light Trespass



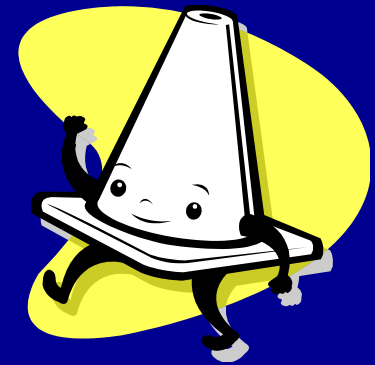
umichstories.tumblr.com

Sky glow

Safety

More light is not necessarily safer

- Overillumination causes shadows
- Glare reduces visibility
- Night vision compromised
- Targets illuminated



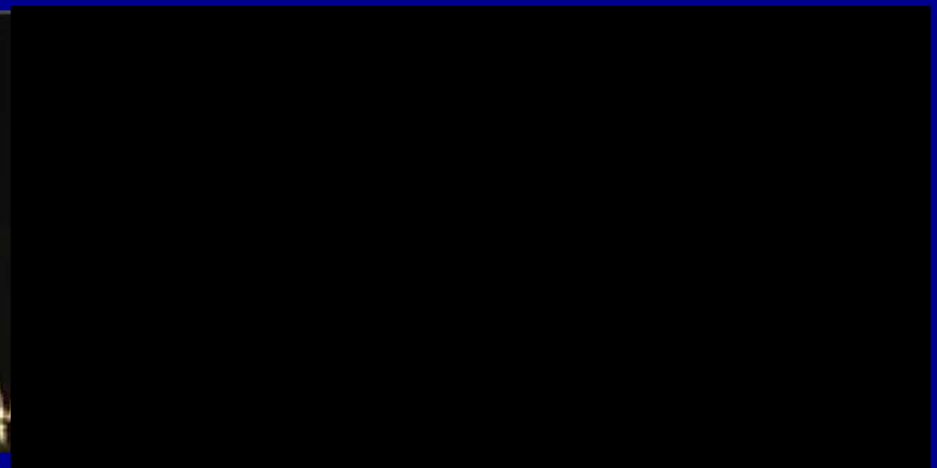
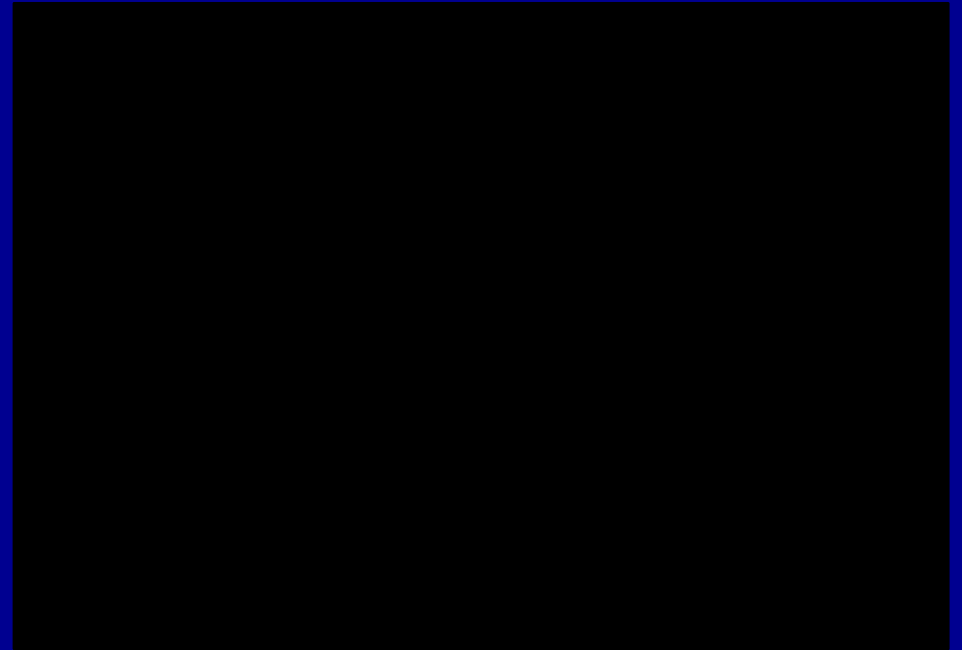


More light ≠ more safe



More light ≠ more safe

Glare reduces visibility



Blue light = Bad!

- Blue light scatters far more strongly
- More disability glare, vision problems
- Blue destroys night vision **more than red**

It is estimated that white LED lamps have five times greater impact on circadian sleep rhythms than conventional street lamps.

--- **American Medical Association**, June 14, 2016

Easy Solutions!

Light only:

- What is needed
- No more than needed
- When needed
- No bluer than needed




PURE *M*ICHIGAN®



6 MI State Parks are Dark Sky Preserves

PURE MICHIGAN®

plus



The map shows the state of Michigan with several locations marked by black dots and lines pointing to their names. The locations are: Mackinaw City, Posen, Alpena, Ossineke, Port Austin, and Clayton. A scale bar indicates 40 miles, and a north arrow is present.

Location	Designation
Mackinaw City	Headlands International Dark Sky Park
Wilderness State Park	Wilderness State Park
Thompson's Harbor State Park	Thompson's Harbor State Park
Rockport State Park	Rockport State Park
Negwegon State Park	Negwegon State Park
Port Crescent State Park	Port Crescent State Park
Lake Hudson Recreation Area	Lake Hudson Recreation Area

KEPT IN THE DARK

In addition to the Headlands International Dark Sky Park in Mackinaw City, designated by the nonprofit International Dark Sky Association, the state of Michigan has six other state parks designated as year-round dark sky reserves, places to enjoy the night sky less obscured by artificial light.

SOURCE: Michigan Department of Natural Resources
MARTHA THIERRY/DETROIT FREE PRESS



Addressing light pollution is consistent with City of A2 environmental initiatives.

New Office of Sustainability and Innovation

A2 Lighting Ordinance: Goals

1. Protect public health and safety
2. Protect the environment
3. Promote energy efficiency, conserve resources and reduce carbon emissions
4. Reduce costs to city, public services, and citizens
5. Support nighttime activities
6. Retain and enhance city character

A2LO Projected Roadmap

- August 14, 2018: Proposal to Planning Commission, formation of Joint WG
- February 2019: Review by Council Member Kathy Griswold
- **March 2019:**
 - **Planning Comm WS, Design Review Board, Historic District Comm**
- April - May?
 - Endorsements by Commissions: Energy, Planning, Environment
- **May? Planning Commission public hearing**
- **June: City Council**
- **July 1, 2019:** A2LO takes effect with start of FY20

Templates



- **International Dark Sky Association (IDA)**
 - 2 Model Lighting Ordinances (MLO)
- **Pennsylvania Outdoor Lighting Council (POLC)**
 - 3 MLOs and on-line implementation advice, mainly townships
- **Plymouth, MN**
 - Minneapolis suburb, pop. 70,000; Money Magazine #1 place to live 2008. Implemented LO in 2004 based on old IDA MLO
- **Tucson, AZ**
 - Decades-old LO for major metro area
- **Luginbuhl MLO**
 - Probably based on Flagstaff LO

Seeking input and endorsement

- Facades
- Curfew
- ?

Please send comments to Sally Oey msoey@umich.edu

Thank you!

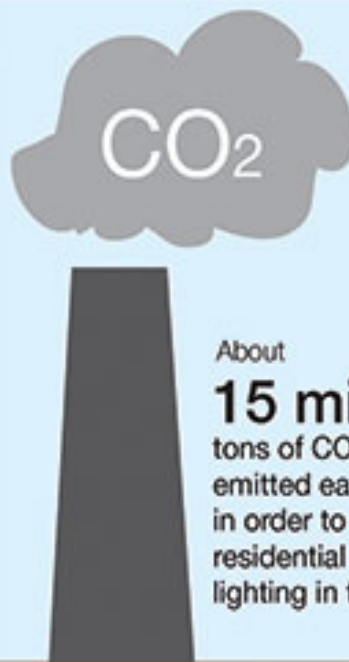
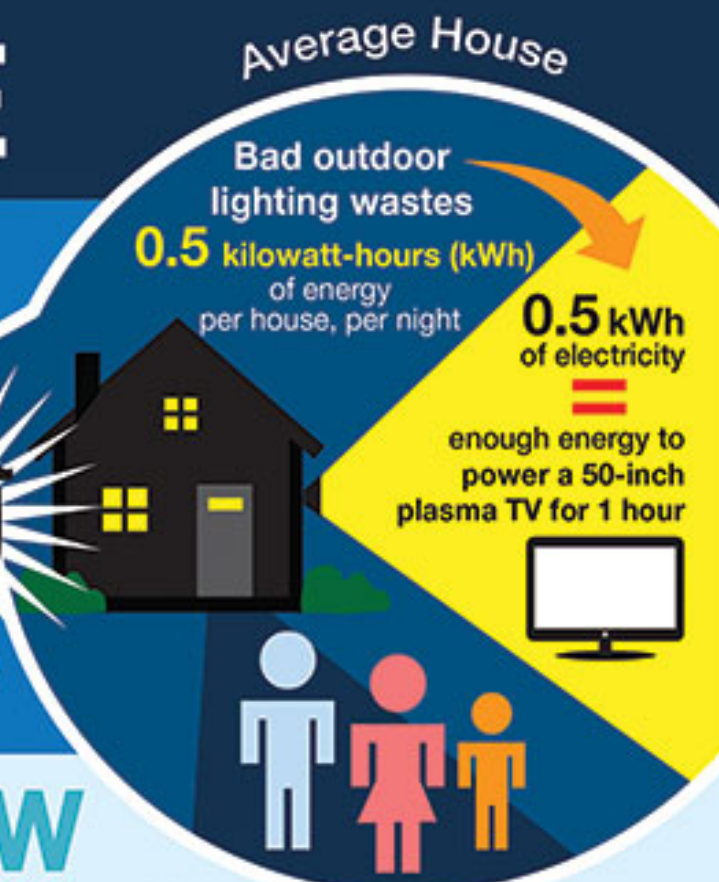
Back-up

ENERGY WASTE

What is light pollution costing us?



13% of residential electricity use in the U.S. is for outdoor lighting



About **15 million** tons of CO₂ are emitted each year in order to power residential outdoor lighting in the U.S.

About **35%** of light is wasted by unshielded and/or poorly-aimed outdoor lighting

SKYGLLOW

is the artificial brightness of the night sky that's caused by light pollution.

This is about **\$3 BILLION** per year worth of energy lost to skyglow



Which is about **\$10.00** spent for every man, woman, and child in the U.S. every year

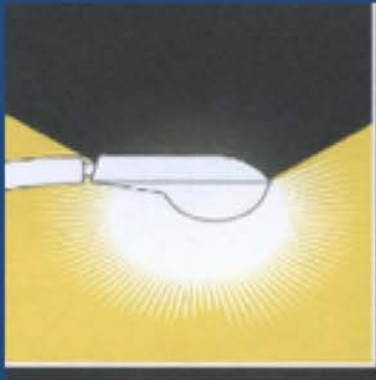
About **3 million** passenger cars have the same CO₂ emission rate, which is 40,000 tons per day.



About **600 million** trees would need to be planted to offset that amount of carbon emission



Shielded Luminaires

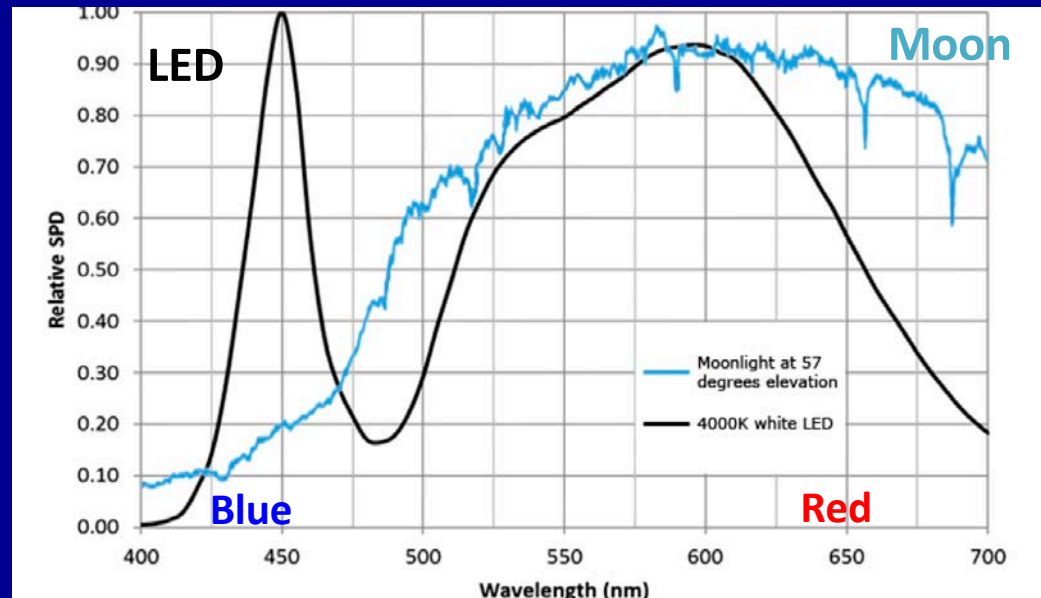


Color Temperature

Specifies color

Caution: can be misleading

LED



Both have Color Temperature = 4000 K

this LED has more blue light

Scattering: Sky glow, Glare

Molecules / air: scattering $\sim \lambda^{-4}$

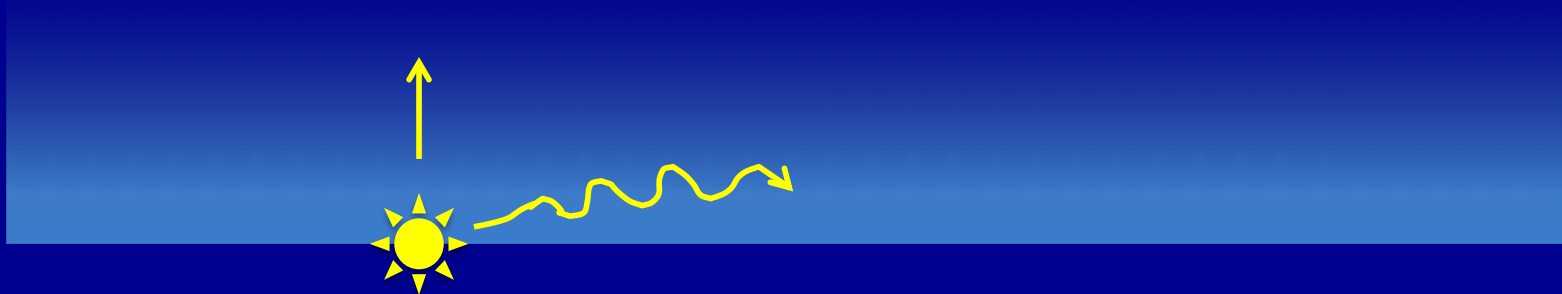
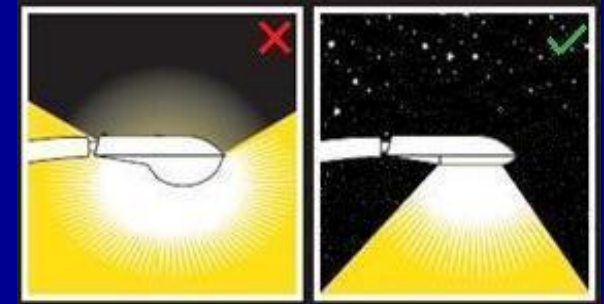
Particles / fog: scattering $\sim \lambda$

Blue light scatters $\sim 10X$
more than red!

White, but **more!**

Oblique upward angles:

- scatter more than vertical
- spread area of light



Brightness is exponential

Full cutoff
shielding is essential!

i.e., zero uplight

Condition	Illumination
	(<i>ftcd</i>)
Sunlight	10,000
Full Daylight	1,000
Overcast Day	100
Very Dark Day	10
Twilight	1
Deep Twilight	.1
Full Moon	.01
Quarter Moon	.001
Starlight	.0001
Overcast Night	.00001

- **Illuminance:** Measure of incident light falling per surface area; illumination. Units = **foot-candles** or lux.
- **Lumen:** Unit of emitted power per solid angle of visible light.
- **Correlated color temperature (CCT):** Measure of light color. It is calibrated against a thermal source spectrum.
- **Color rendering index (CRI):** Measure of how well a source spectrum matches a thermal source spectrum.
- **Fully shielded:** Shielding such that no light is emitted at angles above horizontal.

A2 Lighting Ordinance

- Energy Commission
- Private property

City Policy

- Public rights of way

U of M

- Exempt



Ann Arbor Energy Sustainability

LED Conversion Project Executive Summary (2011):

*...Finally, because LEDs emit directional light, we have more control over what we light (streets and sidewalks) and what we don't (the night sky). **This makes for easier compliance with the Dark Skies Initiative**, which aims to reduce light pollution and its associated wildlife impacts.*

